THE WORK OF MT. PROSPECT LABORATORY OF THE BROOKLYN WATER WORKS

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WITH FOUR PLATES

The practical value of the sciences in our modern civilization is strikingly attested by the increase in the number of laboratories connected with various departments of nation, state and municipality. This is emphatically true in the domain of sanitary science, where the advances in chemistry, microscopy and bacteriology have wrought revolutionary changes. With the knowledge that many diseases are caused by living organisms, and that some of them are transmitted by water, came the need of more careful supervision of public water supplies, which resulted in the establishment of laboratories devoted to water analysis. The pioneer work of the Massachusetts State Board of Health has been followed by the installation of laboratories in most of our large American cities. In many instances these are operated in connection with the departments of health, but in Boston, Lynn, Louisville, Cincinnati, Pittsburg, Albany, Washington, and elsewhere laboratories have been organized in connection with the departments of water supply, either for the purpose of experimental work or because the character of the water supply was such that proper management depended upon analytical as well as engineering data. Departments of water supply should be justly held responsible for the quality as well as the quantity of water supplied to the public. This involves a constant knowledge of the sanitary condition of the water, which can be obtained only by frequent analysis and inspection.

The complicated character of the water supply of Brooklyn made the need of a laboratory apparent to the Department of Water Supply several years ago, but it was not until 1897 that an appropriation for the purpose was obtained. In May of that year the writer was appointed biologist and director of the laboratory, and instructed by Mr. I. M. De Varona, Engineer of Water Supply, to prepare plans for the installation and equipment of a complete chemical and biological laboratory. Mt. Prospect reservoir, near the entrance to Prospect Park, was selected as the most available site, and the gate house of the reservoir was found to have ample accommodations. Contracts were let during the summer, and the laboratory was in complete operation on the 1st of October, though regular microscopical examinations of the water were begun early in July.

Mt. Prospect laboratory has a fortunate location. It is conveniently near the Long Island depot, where the samples from the watershed are received, Ridgewood reservoir, the main distribution reservoir, and the office of the department at the municipal building. Its isolation and elevation make it comparatively free from noise and dust, while the building is well lighted by large windows, heated by hot water, provided with gas, electricity and telephone. The upper portion of the building contains three rooms, besides the keeper's office, and a corridor from which visitors may ascend to an observatory on the roof. The three rooms are known as the general laboratory, or preparation room, the biological laboratory, and the chemical laboratory. In the basement are the physical laboratory, the general store room and the furnace room. There is also a sub-basement, suitable for bacteriological work during hot weather.

The general laboratory is devoted to the shipment of bottles and reception of samples, the washing of glassware, the sterilization of apparatus, the preparation of culture media and to such chemical operations as might charge the air with ammonia and the fumes of strong acids. The room contains a well-ventilated hood; a work table, under which are closets and drawers; a shipping desk; a large sink, with draining boards on the sides; a drying oven; a hot-air sterilizer; a steam sterilizer; an autoclav; an automatic still, and a distilled water tank, lined with block tin and having delivery tubes that extend to the other rooms.

The biological laboratory is devoted to the bacteriological and microscopical examinations of water and to the study of the various organisms found. It also forms the office of the director. It contains a work table; a long work shelf, with three windows in front; three incubators; an ice chest for the storage of culture media; a case for sterilized apparatus;

a bookcase, with a good working library; a desk; a typewriter, and cabinets for report blanks, biological specimens, etc. Electric bells connect with the different laboratories and with the telephone in the office of the keeper of the reservoir.

The chemical laboratory is the largest of the three rooms. Its atmosphere is kept free from ammonia and from the fumes of strong acids, in order not to vitiate the results of the water analyses there carried on. It contains a table for holding the samples of water that are being analyzed; three work tables; two work shelves, with windows in front; a weighing room, with balance in front of window and with a wide desiccator shelf and a drying closet; a hood, under which are two steam baths; a battery of twelve stills for ammonia distillations; a still for obtaining redistilled water; an apparatus for gas analysis; a battery of twelve Sedwick-Rafter filters, used in the microscopical examination of water; an apparatus case; a case for chemicals; a Richards pump, and various pieces of specially designed apparatus that facilitate the work of analysis. The room also contains a combustion furnace and a Mahler bomb calorimeter for the analysis of coal and the determination of its heating power. A storage room opens from the chemical laboratory, and there is a small dark room under the stairs. The three laboratories have marble-tiled floors, and the work tables and shelves are covered with white tiles throughout. The partitions between the rooms are largely of glass.

The physical laboratory in the basement is not fully completed. At present it contains a crusher, a coal sampler, sieves for sand analysis, and a complete equipment for testing cement. Much of the room is devoted to storage and to shop work.

The laboratory force consists of one biologist and director, one chemist, one assistant chemist and three assistants.

WATER ANALYSES

The routine work consists of the regular examination of samples of water received from all parts of the water-shed and distribution system, i. e., from the driven wells, streams, ponds, aqueducts, reservoirs and service taps. The complicated and varied character of the water supply requires the examination of an unusually large number of samples, and it is safe to say that no water supply in this country is examined more thoroughly and minutely than that of Brooklyn. The regular routine includes the bacteriological examination of three samples of water from the Ridgewood pumping stations and from a tap in the city collected daily; the complete physical, chemical and biological examination of nine samples from the distribution system collected weekly; the physical, biological and partial chemical examination of 24 samples from the supply ponds collected weekly, with complete chemical analyses monthly, the complete examination of 19 samples from driven wells collected monthly; and the complete examination of 21 samples from the private water supply companies of Brooklyn and from the water supplies of the Borough of Queens, collected quarterly. In addition to these regular samples many extra samples are taken at various times and places, as occasion requires. During the 2½ years that the laboratory has been in operation this schedule has resulted in the analysis of more than 6,000 samples, as follows:

Samples received from July 12, 1897, to April 1, 1900	6,471
Physical examinations	5,025
Complete chemical analyses	2,562
Partial chemical analyses	1,049
Microscopical examinations	4,688
Bacteriological examinations	5,230
Tests for bacillus coli communis	2,630

The samples of water from the watershed are collected in the forenoon during the early part of each week and sent to the laboratory by express. The average time that elapses between the collection of a sample and the beginning of its analysis is about four hours, but this time varies from ten minutes to eight hours. Samples are collected in large bottles for chemical and microscopical analysis and in small sterilized bottles for bacteriological examination. The large bottles have a capacity of one gallon, are made of heavy, clear, white glass, and have glass "hood" stoppers. They are not sterilized, but are carefully cleaned with chromic acid before leaving the laboratory. Brown paper is tied over the stoppers to prevent contamination from dust, and the bottles are packed in boxes that have separate compartments lined with indented fiber paper and that are provided with tight-fitting covers. The breakage of bottles packed in this way is very small.

The bottles for the bacteria samples hold 2 ozs., and are made of clear, white glass, and have wide mouths with glass stoppers. They are known to the trade as "chemical salt mouths." These bottles are sterilized each time before use. The stoppers of the bottles are covered with pieces of tin foil, and each bottle is then placed in a screw-capped tin box, just large enough to receive it. The tin boxes are painted to keep them from rusting. The bacteria samples are shipped in portable ice-boxes. There is an outer box with asbestos packing and a copper lining and an inner copper tray, divided into compartments to hold the tin boxes just mentioned, and between the outer box and the tray is a large space for ice. The box holds sufficient ice to last eight hours in hot weather, and the samples almost invariably are received in good condition.

The samples from the supply ponds are collected at a depth of 1 ft. below the surface. The shallowness of the ponds makes it unnecessary to collect samples at greater depths. The samples from the distribution reservoirs are collected just outside the gate houses, where the flowing water gives a representative mixture of the water entering or leaving the reservoirs. Special precautions are taken to avoid contamination in the collection of samples, and to this end special forms of collecting apparatus have been devised.

In the apparatus for collecting the bacteria samples the sterilized bottle is placed in a metal frame attached to the lower end of a small brass tube, and is held in position by spring clips. A small rod extends through the brass tube, and at the lower end is provided with a clutch for grasping the stopper of the bottle. By means of this rod the bottle may be opened and closed under water.

The apparatus used for collecting samples from beneath the surface, when necessary, is as follows: The frame consists of a brass wire attached to a weight with clips for holding the bottle. The frame is supported by a spring joined to a sinking rope. A flexible cord extends from the top of the spring to the stopper of the bottle. The length of this cord and the length and stiffness of the spring are so adjusted that when the apparatus is suspended in the water by the sinking rope the cord will be just a little slack. In this condition it is lowered to the desired depth. A sudden jerk given to the rope stretches the spring and produces sufficient tension on the cord to pull out the stopper.

The apparatus for collecting bacteria samples from beneath the surface is similar in principle. The bottle is replaced by a sterilized vacuum tube, with end turned outwards and backwards and drawn to a point. The pull of the cord breaks off the tip of the tube and the pressure of the water causes the tube to fill. The end may be then sealed with an alcohol lamp or closed with a bit of sterilized wax. The frame for holding the tube consists of a short piece of lead pipe, which also serves as a weight.

The temperature of each sample is taken at the time of collection and recorded on a certificate, together with the locality of the sample, the date of collection, the name of the collector, etc. Temperature reading below the surface are obtained with the thermophone.*

When the samples reach the laboratory each is given a serial number and entered in an index book, and throughout all the examinations each sample is known by its number rather than by the name of the locality from which it was collected.

It would be out of place in this paper to describe in detail all the methods used in the analysis of the samples, but inasmuch as methods differ considerably in different laboratories, it seems desirable to give at least an outline of the methods used and to describe such as differ materially from those practiced elsewhere.

PHYSICAL EXAMINATION

The physical examination includes the observation of the temperature of the water, its general appearance, its turbidity, its color and its odor.

Temperature.—The temperature of the sample is observed at the time of the collection, as mentioned above.

Appearance.—The amount of sediment and the turbidity, after standing twelve hours, are estimated by inspection and recorded numerically according to the following scale: 0, none; 1, very slight; 2, slight; 3, distinct; 4, decided.

Turbidity.—The actual turbidity is determined by comparison of the sample with silica standards of turbidity, as described by Whipple and Jackson in the Technology Quarterly for December, 1899, and September, 1900. According to this standard, a turbidity of 100 is equal to that produced by adding 100 mg. of finely divided diatomaceous earth to one liter of water. Comparisons are made in gallon bottles or in

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*Henry E. Warren and Geo. C. Whipple, "The Thermophone," Technology Quarterly, July, 1895.

Nessler jars, held toward the light or placed over a series of black lines.

Color.—The color is determined by comparison with the platinum-cobalt standard, described by Hazen in the American Chemical Journal, Vol. XIV, p. 300. The comparisons are made in 100 cu. cm. Nessler jars, 1 in. in diameter and 12 ins. long.

Odor.—The "cold odor" is observed after vigorously shaking the bottle in which the sample is contained. The "hot odor" is observed by heating about 200 cu. cm. of the sample in a beaker, covered with a watch-glass, to a point just short of boiling and applying the nose as soon as the water has sufficiently cooled. The results are expressed according to the following scale of intensity and with the following abbreviations:

Scale of intensity.—0, none; 1, very faint; 2, faint; 3, distinct; 4, decided.

Abbreviations.—v, vegetable; e, earthy; a, aromatic; g, grassy; f, fishy; m, moldy, etc.

CHEMICAL ANALYSIS

The sanitary chemical analysis ordinarily includes the determination of the nitrogen as albuminoid ammonia, free ammonia, nitrites and nitrates; total residue on evaporation, loss on ignition, chlorine, iron and hardness. In addition to these the following determinations are sometimes made: oxygen consumed, alkalinity, incrusting constituents, dissolved oxygen, carbonic acid, etc.

Form of Expression.—The results of the chemical analysis are expressed in parts per million.

Nitrogen as Albuminoid Ammonia.—The method of Wanklyn is used, according to the practice of the Massachusetts State Board of Health, described in the two special reports on water supply and sewerage published in 1890. The total albuminoid ammonia is determined on the unfiltered water. The dissolved albuminoid ammonia is determined after filtering the sample through filter paper. The suspended albuminoid ammonia is found by subtracting the dissolved albuminoid ammonia from the total albuminoid ammonia. In the case of ground waters only the total albuminoid ammonia is determined. The form of distilling apparatus is practically the same as that designed by Mr. H. W. Clark and used at the laboratory of the Massachusetts State Board of Health. Permanent standards are used as described by Jackson in the Technology Quarterly for December, 1900.

Nitrogen as Free Ammonia.—The free ammonia is determined by Wanklyn's method, referred to under albuminoid ammonia. Five hundred cu. cm. of the sample serves for the determination of both the free and albuminoid ammonia.

Nitrogen as Nitrites.—Warrington's modification of the Griess method is used. Permanent standards are used.

Nitrogen as Nitrates.—The phenolsulphonic acid method of Grandval and Lajoux is used, but with certain modifications tending to refinement. The quantities of water operated upon vary from 2 to 50 cu. cm., according to the amount of nitrogen present as nitrates. Permanent standards are used instead of preparing fresh standards for every set of comparisons. Comparisons are made in 100 cu. cm. Nessler jars.

Residue on Evaporation.—For the determination of the residue on evaporation 200 cu. cm. of the sample are evaporated to dryness on a water bath in a platinum dish of known weight, dried for half an hour in a steam oven, cooled in a desiccator and weighed. Where it is necessary to determine the amount of suspended matter the residue is determined both before and after filtering the sample through filter paper or through a Pasteur filter, and the difference obtained.

Loss on Ignition.—After the determination of the total residue on evaporation the platinum dish is placed in a larger platinum dish that serves as a radiator, ignited for seven minutes at a low red heat, treated with a small amount of distilled water to restore any loss of water of crystallization that may have been driven off by the ignition, evaporated to dryness on the water bath and dried, cooled and weighed as before. The difference of weight before and after ignition gives the loss on ignition. The loss on ignition is not determined for the ground waters or for the water of the distribution system, which is a mixture of the surface and ground waters.

Chlorine.—The chlorine is determined by titration with silver nitrate, using potassium chromate as an indicator, according to Hazen's modification of Mohr's method, described in the American Chemical Journal, Vol. XI, p. 409.

Hardness.—The hardness is determined by Clark's soap method, substantially as described in Sutton's "Volumetric

Analysis," but with certain modifications in the preparation of the soap solution. No attempt is made to separate the "temporary hardness" from the "permanent hardness" by the method of boiling. The information covered by these terms is obtained when required by the determination of the alkalinity and the incrusting constituents.

Alkalinity.—The alkalinity of a water is a measure of the carbonates and bicarbonates present. It is ordinarily determined by titrating 100 cu. cm. of the sample with N-50 H_2SO_4, using methyl orange as an indicator; but it is sometimes desirable to substitute lacmoid for methyl orange as an indicator, making the titration after heating the sample to the boiling point. Phenacetolin is also used. It has been found that when the true end-points are known and the proper corrections are applied the various indicators give practically the same results. These indicators differ in their power of showing the presence of sulphate of alumina, and methyl orange should not be used in determining the alkalinity of a water that has been treated with that coagulant.

Incrusting Constituents.—The incrusting constituents are the salts that give to water its "permanent hardness." The determination is made according to Hehner's method, as described by Leffman in his "Examination of Water." The sum of the alkalinity and incrusting constituents is approximately equal to the hardness as determined by the soap method.

Iron.—The iron is determined from the residue in the platinum dish according to Thompson's method, as described in Sutton's "Volumetric Analysis," but with certain changes in technique that tend to greater accuracy.

Oyxgen Consumed.—The Kubel method is used substantially as described in the special reports of the Massachusetts State Board of Health, above referred to. The period of boiling is five minutes. This determination is seldom made on the regular samples.

Dissolved Oxygen.—Winkler's method is used according to the modifications of Drown and Hazen, described in the special reports of the Massachusetts State Board of Health, above referred to.

Carbonic Acid.—Pettenkofer's method is used according to the modifications of Trillich, described in Ohmuller's "Untersuchung des Wassers," edition of 1896, when it is desired to determine the free and half-bound carbonic acid. The free carbonic acid is determined by titrating with N_{22}NaOH, using phenolphthalein as an indicator.

MICROSCOPICAL EXAMINATION

The microscopical examination of water determines the number and kind of microscopic organisms present, together with the amount of amorphous matter. The Sedgwick-Rafter method is used, with the modifications described in the author's "Microscopy of Drinking Water." The results are expressed in number of standard units of organisms per cubic centimeter.

BACTERIOLOGICAL EXAMINATION

The bacteriological examination consists of the determination of the number of bacteria present in a sample of water and a qualitative test for the presence of bacillus coli communis. No general qualitative work is undertaken in connection with the regular routine.

Quantitative Examination.—One cubic centimeter of the sample (diluted 1-10, or 1-100, if necessary) is mixed with 5 cu. cm. of sterilized nutrient gelatine in a ventilated petri dish and allowed to cool on a level surface. When hard the culture is placed in an incubator and kept at a temperature of 20° C. in an atmosphere saturated with moisture for 48 hours, after which the number of developed colonies is counted. It is then returned to the incubator and kept 24 hours longer, after which a second count is made. The 72-hour count is the one reported. All determinations are made in duplicate. The gelatine used as the culture medium is prepared substantially as recommended in the report of the Bacteriological Committee of the American Public Health Association, published in 1898. It is given an acidity of 1.5%.

Test for Bacillus Coli Communis.—Smith's fermentation method is used as the basis of the test, isolation of the colon bacillus according to ordinary qualitative methods being attempted only when a positive test is obtained in the fermentation tube. If the amount of gas in the fermentation tube after 48 hours' incubation at 37° C. is above 30% and below 70% of the closed arm, a portion of the sediment is plated on lactose-litmus-agar. If red colonies develop after 12 hours' incubation transfers are made from them to glucose-gelatine, milk, nitrate solution, sugar-free broth (for indol), and glucose broth in a fermentation tube. If these tests give positive results, the presence of the colon bacillus is considered as proven.

The members of this Society will be naturally most interested in the results of the microscopical examinations. These cannot be described in detail within the compass of this paper, but the following account of some of the more important microscopic organisms will indicate the nature of the problems that are being investigated.

MICROSCOPIC ORGANISMS IN THE BROOKLYN WATER SUPPLY

The troubles of the Brooklyn water supply during the past few years have been occasioned by the growth of odor-producing organisms in the distribution reservoirs. The growth of Asterionella in Ridgewood and Mt. Prospect reservoirs and its effect upon the quality of the water have been so fully described (report of Dr. Albert R. Leeds to the Department of City Works, Division of Water Supply, Brooklyn, 1897) that it is not necessary to again relate the details of its occurrence. That the growths of Asterionella continue to occur periodically is shown by the diagram.

Asterionella is not the only odor-producing organism that develops in the distribution reservoirs. Anabaena, Synedra, Cyclotella and other forms are sometimes present in great abundance. The character of the water collected from the watershed of the Brooklyn supply is such as to furnish abundant nourishment for microscopic plant life, and organisms that in many water supplies appear in small numbers without having any noticeable effect on the character of the water develop in Brooklyn to an enormous extent.

This is emphatically true in the case of Synedra pulchella, a diatom that until recently has not been classed as an odor-producing organism. Like Asterionella, this diatom contains oil-globules, but the oily substance has not the same strong odor as the oil of Asterionella. Nevertheless, Synedra is capable of imparting an odor to water if present in sufficient numbers. The odor is not a characteristic one like that of Asterionella, Uroglena, Dinobryon, etc., and can be described by no more exact term than "vegetable." The taste imparted to water by Synedra is perhaps more noticeable than the odor, being somewhat "earthy," as well as "vegetable."

In few water supplies in this country is Synedra pulchella ever present in numbers greater than 5,000 per cu. cm. and, although a smaller number than this will make a water turbid, it requires about this number to produce a noticeable odor. In Brooklyn, however, the growths of Synedra have been much heavier, as may be seen from the diagram. On several occasions the numbers have reached 15,000 per cu. cm., and once as many as 20,000 per cu. cm. were observed. The water at such times has been very turbid, and has had the vegetable and earthy taste and odor just referred to.

The seasonable distribution of Synedra in the Brooklyn reservoirs is worth noting. In Mt. Prospect reservoir it has appeared regularly in the spring and fall, according to the usual mode of occurrence of the diatoms, but it has always appeared after the Asterionella growths in the spring and before the Asterionella growths in the fall. In Ridgewood its occurrence has been more variable. In 1899 there were heavy growths in basins 1 and 3 during the month of August.

Cyclotella is another diatom that, because of its limited occurrence, has been seldom known to cause trouble in water supplies. Yet in Ridgewood reservoir it is sometimes present in large numbers. Its growth has been usually of short duration, but when present in numbers equal to 5,000 standard units per cu. cm. its aromatic odor could be distinctly recognized.

Two species of Melosira occur in the Brooklyn supply. Melosira granulata, the common free-floating form, is seldom present in sufficient numbers to cause trouble, though 2.000 or 3,000 per cu. cm. are sometimes found. Melosira varians grows luxuriantly on the shores of Ridgewood reservoir, and constant scraping is required during the summer to keep the banks clean. During severe storms the filaments of Melosira become detached from the shores and are scattered through the water, and on one occasion the amount of vegetable matter so detached was sufficient to impart a distinct taste to the water. Like Synedra pulchella, Melosira produces simply a vegetable, earthy and somewhat oily taste and odor, very different from the aromatic-fishy odor of Asterionella and Cyclotella.

Next to Asterionella, Anabaena has probably caused more trouble in the Brooklyn water supply than any other organism. During the past two years it has appeared but once, but there are good reasons to believe that in the summer of

1896, prior to the investigations of Dr. Leeds, the disagreeable odor of the tap water was due not so much to Asterionella as to Anabaena.

In July, 1898, Anabaena appeared in all the Ridgewood basins. In Basin 3 it did not develop to any extent. In Basin 1 it attained a maximum growth of 1.720 standard units per cu. cm. on August 19, and gave to the water its characteristic odor of moldy grass. In Basin 2, however, it developed to an enormous extent. On August 3 there were 24,000 standard units per cu. cm. From the last of July until early in September the water in the basin was intensely turbid and had a green color. On quiet days a scum collected on the surface and drifted about with the wind. The water was entirely unfit for use, and the gates of the reservoir were kept closed. As soon as the organisms disappeared in the fall and the water had again assumed its normal condition, Basin 2 was emptied and cleaned, with the hope of preventing recurrence of such growths in the future. An examination of the deposit at the bottom of the reservoir showed that it was well seeded with the spores of Anabaena. Since that time there has been no further development of this organism.

In September, 1898, a phenomenally large growth of Scenedesmus occurred in Mt. Prospect reservoir, the water at one time containing 25,800 standard units per cu. cm. This organism, in the numbers ordinarily found, causes no odor, but on this occasion the water had a distinct vegetable and aromatic odor and taste. The growth continued for several weeks.

There are several other organisms that deserve mention, because they occur in larger numbers in the Brooklyn water than in most water supplies. Dictyosphaerium, Eudorina, Pandorina and Volvox are often present in numbers of 500 standard units per cu. cm. Clathrocystis is not often found in Ridgewood reservoir, but in Mt. Prospect reservoir it has been as high as 1,440 standard units per cu. cm. As a rule the Brooklyn water contains comparatively few protozoa, but Mallomonas has been observed as high as 660 per cu. cm. in Ridgewood reservoir, and Cryptomonas has been as high as 2,000 per cu. cm. in Mt. Prospect reservoir. Chlamydomonas has been found occasionally.

To the water consumers of Brooklyn, however, the important fact is not the number of organisms in the distribution reservoirs, but the number present in the tap water in the city. Prior to the construction of the by-pass at Ridgewood the organisms that developed in the reservoir found their way as a matter of course to the service taps of the consumers. But by using the by-pass it has been found possible to so regulate the distribution of the water that very few organisms reach the consumer. Guided by the frequent and regular microscopical examinations made at Mt. Prospect laboratory, the engineer has directed one or more basins to be isolated whenever it was found that odor-producing organisms were developing in them, the water meanwhile being delivered through the by-pass direct from the force mains to the distribution pipes. It has been found possible also to isolate Mt. Prospect reservoir and pump directly into the pipes when growths of organisms made it seem advisable. The beneficial effect of this management can be illustrated by the following comparison.

At the time when Dr. Leeds made his report on the condition of the water, i. e., from November, 1896, to February, 1897, Asterionella was present in the distribution system as follows:

	No. per cu. cm.
Ridgewood reservoir, Basin 1	3 to 48
" " " 2	2 " 10
" " " 3	2,608 " 4,648
Mt. Prospect reservoir	4,808 " 8,640
Tap supplied from Ridgewood, Basins 1 and 2	3 " 81
" " " " Basin 3	1,240 " 8,800
" " " Mt. Prospect reservoir	2,400 " 7,460

During November and December, 1899, the corresponding figures were as follows:

	No. per cu. cm.
Ridgewood reservoir, Basin 1	5,600 to 27,280
" " " 2	0 " 8
" " " 3	0 " 16
Mt. Prospect reservoir	6,512 " 24,960
Tap ordinarily supplied from Ridgewood, Basin 1 and 2	0
Taps supplied from Ridgewood, Basin 3	0 " 16
Tap ordinarly supplied from Mt. Prospect reservoir	8 " 56

During November, 1896, and February, 1897, the water supplied to the city from Basin 3 and from Mt. Prospect reservoir had a very disagreeable taste and odor, due to the presence of Asterionella, but during November-December, 1899, the water in the city had no odor due to Asterionella, even though that organism was far more abundant in Ridgewood and Mt. Prospect reservoirs than it had been during the winter of 1896-97. This freedom of the tap water from Asterionella was due to the use of the by-pass, the sections of the city that are ordinarily supplied from Ridgewood Basins 1 and 2 and from Mt. Prospect reservoir being supplied with water direct from the Ridgewood force mains.

EXPLANATION OF PLATES

Plate I

Exterior view of Mount Prospect Laboratory, Brooklyn Water Works.

Plate II

Plan of main floor, Mount Prospect Laboratory.

Plate III

View of a portion of the Chemical Laboratory.

Plate IV

Variations in numbers of microscopic organisms in the Brooklyn Reservoirs, November, 1897, to February, 1900.